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SCIENCE, RELIGION AND SOCIAL ETHICS[1]

By Sir RICHARD GREGORY, BART.

RETIRING EDITOR OF NATURE

MANY reasons have been put forward to account for the origin of religion, but it can not be said that any of them have solved the problem. Ancestor worship, ghost propitiation, worship of the soul, belief in spiritual beings, reverence for tribal leaders, have all been suggested as originating causes of religious sentiment. Primitive man had no religion except such as was embodied in a system of social virtues. Men possessing these virtues to a high degree, and using them to make the tribe powerful or conditions of life more pleasant, would be esteemed as benefactors or heroes not only during life but after death, and this veneration would develop into ancestor worship and later into soul worship.

[1] Concluding part of the fifth Elihu Root Lecture of the Carnegie Institution of Washington, given on December 8, 1938. The substance was included in a lecture before a general session of the American Association for the Advancement of Science, Richmond, Virginia, December 29, 1938.

If it is assumed that the divine purpose of the existence and evolution of life upon the earth is that man should work out his own salvation, it is difficult to understand what the ultimate gain will be when the earth will no longer be in a condition to maintain life as we conceive of it. All that science can say as to the future of the earth, or of any other planet or system in the astronomical universe, is expressed in the words of the hymn, "Our little systems have their day: they have their day and cease to be." We may contemplate the progressive development of man and society to any stage that may satisfy our ideals, but, so far as we now know, the whole phantasmagoria will eventually be dissolved, and the death of mankind will be the final penalty for achieving the highest type of humanity conceived by the human mind. This thought should not, however, be subversive of effort and aspiration on the part of humanity as a whole, any more than the

individual should neglect noble motive and conduct because he himself has to pass away whether his influence has been for good or evil. Though science is unable to provide any positive evidence for survival of personality after death, it must acknowledge that belief in such survival is a powerful ethical factor in human development. It is just as permissible, therefore, to assume that another world awaits habitation by an exalted type of humanity after this earth has come to an end, as it is to believe in the eternal existence of individuality.

Whatever convictions may be held as to the future of man or humanity, the standard of goodness is decided by the community. The man who lives a moral life merely because he wishes to save his own soul is little better than an expectant hedonist; for his motive is personal profit. He may be saved from punishment hereafter by being negatively evil, but his life will be of no benefit to the human race unless he is positively good. What existence awaits us when we are called away we can not say, but we find stimulus and high endeavor in the hope that each thread of life is intended to contribute to the web designed by its Creator. Though science may not be able to contribute much to the ultimate problems of spiritual beliefs, it does teach that every action carries with it a consequence—not in another world, but in this—to be felt either by ourselves or by others in our own time or the generations to come.

Evidence of the progressive development of forms of life in the past and of changes still going on is so convincing that it may almost be regarded as a law of nature. In so far, therefore, as evolution signifies an orderly succession of organic growth, few would venture to deny the fact; but how and why such changes are brought about has not yet been established beyond discussion. Whether organic evolution has proceeded by gradual development of small variations of structure and habits, or by the sudden appearance of new forms, is a question for naturalists to decide among themselves in their search for natural causes. The court of observational science is concerned only with evidence which throws light upon such causes, without assuming the existence of supernatural design or intervention. Whether behind the natural causes producing evolution there is a transcendental principle or architect is not the concern of naturalists but of other philosophers. Their position is that even if the facts of organic evolution can not be explained by existing knowledge, they will be explicable when more is known about natural causes and consequences, without introducing a *deus ex machina* to conceal our ignorance and suppress the pursuit of objective evidence.

We have passed the stage when, in order to afford support for Christian belief in general, and the Mosaic account of creation in particular, it was only necessary to find naturalistic or rationalistic explanations of miraculous and other elements in biblical records. Such attempts to fit all new knowledge into a system of thought having no claims to scientific accuracy or intention served no useful purpose to the Bible or to science, and to-day would satisfy neither historical students nor naturalists. A much sounder basis can be found by applying evolutionary principles to religious thought and by studying sacred books as stages in the story of man's progressive discovery in theology. It is only by disregarding history that the idea of a fixed and final theology becomes possible. In science, there are no final interpretations or unchangeable hypotheses; and if the same principle were recognized in theology, religion would share some of the vitality of the natural sciences. Evolution can be regarded by the theologian as merely the means of creation; and the conception of gradual development is not incompatible with Christian theology. It is through the acceptance of the idea of evolution in the spirit as well as in the body of man that the partition which formerly separated religion and science is being dissolved.

In recent years, there has been much discussion of the ethical or social consequences of the application of mechanical and other scientific discoveries to industry. In the early days of the industrial revolution in England, there was little of the scientific spirit in industry. The discoveries of science were used with as much indifference to science as to humanity. The inventions of the eighteenth and early nineteenth centuries came from the workshop rather than from the scientific laboratory. Machines were devised and operations developed largely by trial and error methods, and academic research had few points of contact with industrial practice. The characteristic of the present age is the utilization in industry of principles, properties and products revealed by scientific research, whether carried on solely in the pursuit of knowledge or with a practical purpose in mind.

It is sometimes suggested that progressive science and invention are responsible for the troubled condition of the world at the present time, owing largely to overproduction. It would be just as reasonable to blame the Almighty for good harvests, or for providing in some parts of the world all the means of existence for primitive man without the need for labor. The fault is not with those who create gifts for men's comfort and enjoyment, but with the social system which prevents their easy distribution and use. A century ago, most of the machines and engineering works which now make up a large part of our industrial life, and which are supposed to have led to unemployment, did not exist, yet there was then wide-spread unemployment and poverty. The population of Great Britain was

then only sixteen millions, yet there were two millions in workhouses or receiving outdoor relief. The terrible conditions of those days were bitterly described by Carlyle in "Past and Present." He wrote:

> We have more riches than any Nation ever had before; we have less good of them than any Nation ever had before. Our successful industry is hitherto unsuccessful; a strange success if we stop here! In the midst of plethoric plenty, the people perish; with gold walls and full barns no man feels safe or satisfied. Workers, master workers, underworkers, all men, come to pause; stand fixed, and cannot go farther.

In the "hungry forties" the mechanization of transport and industry was but in its early stages, and if the description of Carlyle is a correct one it is apparent that there is little justification for trying to lay the blame for the unemployment of to-day at the feet of the mechanical inventors. When Carlyle wrote, men still traveled by stagecoach and sailing ships, and a multitude of things were done by manual labor which to-day are done by machinery. When first introduced, new machines, it is true, do tend to displace labor in one direction, only, however, to stimulate it in another, and in the end greater wealth is created. The problem to-day, as it was a century ago, is to adapt the social and economic systems to the new conditions brought about by advances of science and invention. For a people to be made wretched in proportion to the increase of means of producing plenty shows that there is something radically wrong in industrial or social economics.

It is of course natural that labor, with its memory of bitter struggles against long hours and low wages, should stress much more acutely the problem of distribution of the products of its toil than that of the factors of industrial progress. The artisan has had good reason for regarding every labor-saving device as a wage-saving device; and it is almost a mockery to suggest to men who find themselves unwanted through the introduction of particular machinery that the ultimate effect will be increased employment. The thought, however sound it may be in industrial economics, affords poor satisfaction for present needs. Men thus displaced through no fault of their own may rightly claim, on the ground of humanity alone, that the community which is eventually to benefit by the saving in costs of production should accept a measure of responsibility for the maintenance of those whose means of existence are suddenly taken from them.

In the history of early civilizations, a condition of stagnation and of internal dissention has usually preceded their decline and extinction. The end has come through conquest by military forces of a superior type or by the invasion of hordes of barbarians whose only motive was plunder. It used to be suggested that modern civilization would be saved from this fate by the powers with which science has provided civilized peoples to protect themselves against overwhelming numbers having only primitive weapons. Few people thought that the yellow and dark races would ever be able to dispute the supremacy of the white races, even though equipped with modern weapons, but that view could scarcely be held to-day. The perils which threaten modern civilization are not, however, so much from the greater numbers of peoples who may eventually possess powerful appliances of war as from the very peoples who have themselves perfected such weapons. Efficient barbarity made no distinction in the Great War between the destruction of masterpieces of architecture and ammunition dumps; and, since then, aerial bombing of any center of life or of beauty seems to be accepted as a means of offensive action by nations which claim to be civilized. Instead of science having to save modern civilization from being overwhelmed by barbarous hordes, it seems to have provided the means of self-destruction. Man has advanced so little in spiritual evolution that he is just as much a barbarian in his use of aerial bombs and poison gas as he was when his weapons were only clubs and arrows.

Such prostitution of the rich gifts with which modern science has endowed the human race must be condemned by all who see, in the general feelings of civilized people to-day, incipient stages in the development of characteristics which distinguish man from other living creatures. The law of the jungle is that of the battle to the strong, and the race to the swift. It recognizes no right to live except by might; destroys the weak; has no sympathy with suffering, and no sense of the highest human values. In the struggle for existence, man has survived because his physical structure and intelligence have enabled him, individually and in communities, to master the things which would destroy him. His social instincts have at the same time been extended from the family to the tribe, the nation and the empire, and will reach their highest and best when they embrace the world.

The virtues which should be prized most to-day, if civilization is to mean the evolution of social ethics to a noble plane, are regard for spiritual values, love of truth and beauty, righteousness, care for the suffering, sympathy with the oppressed and belief in the brotherhood of man. These are the principles of the Sermon on the Mount; and they must be accepted by all who believe in progressive human development. And nation or people which separates itself from the rest of the world in the name of race or religion, and cultivates ideals of conquest by force in order to assert its claims, is not assisting human evolution but retarding it.

Science has made the world one through the facilities of communications and transport now available; and it recognizes no political or racial boundaries in its fields of knowledge. Among modern social and intellectual forces, science alone speaks in a tongue which meets with universal understanding. The conception of science as a social factor intimately linked up with human history and human destiny gives a new meaning not only to scientific research but also to the position of citizens who are engaged in it.

Both rightly and wrongly, science has been blamed for much of the wastage of life which has been brought about by the rapid applications of scientific knowledge to purposes of peace and of war. Men of science are, however, citizens as well as scientific workers; and they are beginning to realize their special responsibilities for making sure that the fruits of scientific knowledge are used for human welfare. They can no longer remain indifferent to the social consequences of discovery and invention, or be silent while they are blamed for increasing powers of production of food supplies, providing means of superseding manual labor by machines and discovering substances which can be used for destructive purposes. It would be a betrayal of the scientific movement if scientific workers failed to play an active part in solving the social problems which their contributions to natural knowledge have created.

The view that the sole function of science is the discovery and study of natural facts and principles without regard to the social implications of the knowledge gained can no longer be maintained. It is being widely realized that science can not be divorced from ethics or rightly absolve itself from human responsibilities in the application of its discoveries to destructive purposes in war or economic disturbances in times of peace. Men of science can no longer stand aside from the social and political questions involved in the structure which has been built up from the materials provided by them, and which their discoveries may be used to destroy. It is their duty to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown through the release of uncontrolled sources of industrial production and of lethal weapons.

Science can only continue to render its fullest service to the community as the relations between the general scientific worker and the general citizen are harmonized and the purposes and methods of science are widely understood. In the establishment of such a sympathy, a nobler type of citizenship becomes possible, adequate to defend us against the dangers to which civilization is exposed and to build a social order worthy of the limitless powers which the advance of science has placed in the hands of man. It is in the light of service to these high ideals that science, without which we can not live, and religion, without which most people see no meaning in life, can find a field in which both can work together for the highest human destiny.

CONCERNING ECOLOGICAL PRINCIPLES[1]

By Professor W. C. ALLEE and Dr. THOMAS PARK
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THE statement is frequently made that ecology deals mainly with facts which are organized around relatively few principles. Usually this is given as a reproach by non-ecologists, sometimes if not with pride, at least with resignation, by ecologists. If such a condition exists, it seems to us to be a cause for regret. For a number of years we have been interested in thinking over this problem and in collecting distinctly ecological principles from the literature as well as in amassing evidence dealing with more specific problems. The present paper is presented as a report of progress in the hope of provoking discussion which may make future ecological work more effective.

In making this study we are not conscious of having contributed anything new, even though we find the results at least mildly stimulating. It is not our concern at present to deal with the history, with the personalities associated with the different principles or with the date of their discovery. This means that we are not particularly interested in the percentage of these principles which have grown out of modern, self-conscious ecology. Our only care has been to select and make some preliminary attempts at classification of those principles that deal in the main with interrelations between an organism, or one or more groups of organisms, and its or their environment.

It would be relatively easy to become entangled in a discussion of terminology in connection with the consideration of ecological principles. We wish to avoid this as far as possible and shall at times use only one of a number of common terms associated with a given idea. Our selection in such cases will be based on our personal usage rather than on a fully reasoned consideration of the merits of possible alternative terms. Our whole emphasis for the moment is on ecological ideas which we think have merit, rather than on ter-

[1] We are indebted to Alfred E. Emerson and to Karl P. Schmidt for reading a preliminary draft of this manuscript and for making pertinent suggestions.

minology or even on the evidence that supports these generalizations.

With this general introduction, it is desirable to give a few orienting definitions and ideas. A principle is a fundamental truth or a proposition which can form the basis of reasoning. It represents a synthesis of data and concepts which have been gained by analysis. A living organism, as well as we can define it, is a physico-chemical mechanism in dynamic equilibrium which displays the self-regulating, self-perpetuating qualities which in the aggregate we call life; or it is such a mechanism plus some powers and forces unknown to modern physics and chemistry, which may or may not be within the range of human knowledge. The environment of any organism consists of everything in the universe external to the cells and intimately utilized cell products of that particular organism. No part of this environment is without potential effect on any organism, although some phases have such a direct importance that they are regarded as comprising the effective environment. The distinction between the effective and the non-effective environment is one of degree of influence rather than of kind. The relation between any living organism and its environment is, in the language of Professor Pearl,[2] (1) particular, (2) continuous, (3) reciprocal and (4) indissoluble. Since we are considering the organism as a unit, we do not need to discuss matters concerned with the intra-organismal environment.

It is not advisable in the present state of our knowledge to dwell upon a general scheme of classification of ecological generalizations. We feel, however, that such a scheme can be worked out and that by making certain assumptions, ecological concepts and principles may be grouped at least as logically as the phenomena on which they are based.

Some of the possible subdivisions are (a) into these generalizations which are primarily quantitative as contrasted with those which, as far as we now can see, are qualitative only. The former may be illustrated by what we know concerning the growth of experimental populations. On the other hand, our information about protective coloration, for example, is as yet primarily qualitative. From a different point of view (b) principles can also be divided into the relatively few in which causal relations are known, as contrasted with the many for which the underlying causes are still obscure. The rough classification we shall follow is mainly one of convenience and is based on fairly obvious primary relationships.

There is a whole series of principles concerned more primarily with the environment than with the organism and another series in which the point of view is reversed. To the working ecologist the environment is holocoenotic, that is, it is a unit composed of many parts, as a rope is made of many strands. Even though holocoenotic, the different parts may at times assume control as the concentration of one of them approaches the minimum or maximum which the animal can tolerate and hence acts as a limiting factor. Here we have the well-known "law" of the minimum and the less emphasized "law" of the maximum. Here also arises the concept of an ecological optimum and with its opposite, an ecological pessimum. The degree of fitness which organisms and environment exhibit may be thought of as ecological valence or öky. From this we move on the one hand to the general idea of euröky and stenöky, which may be broken down into wide or narrow toleration for the different elements in the environment. On the other hand, there is the concept of vagility which is concerned with the powers of dispersal of a given species, or by extension, of a given community. This capacity for active dispersal or passive transport is an important factor in determining geographic range.

There are many rules that have been worked out concerning the effect of environmental factors on organisms; for example, the Arrhenius, Van't Hoff and Krogh temperature equations, the matter of temperature summation and its corollary, the life zone concept, which is closely related to the so-called bioclimatic law. In this general category belong also the different principles concerning the effect of light on organisms, such as the Bunsen-Roscoe "law" which states that the effect of light is, within limits, a function of intensity multiplied by duration of its action; the rule that only absorbed light is effective and that the percentage of incident light which is absorbed is independent of the amount present; and many more. There are also the various applicable laws concerning vapor pressure of water, of hydrostatics and of similarly fundamental principles of meteorology, geology, physics and chemistry which concern the fitness of the environment to support life. In many of these physical relations we must recognize short, intermediate and long-time periodicities as well as important elements of stability in the environmental complex. Phenomena associated with migration and emigration are related to certain of these environmental periodicities.

In shifting our attention so as to consider organisms more directly, we come immediately upon adaptation, which is, of course, correlated with ecological valence. The latter is a term sometimes used by ecologists to express the mutual requirements of environment and organism. Various attempts to organize ecology about types of specific adaptation have failed, but the fact remains that an organism must have a somewhat larger number of positive than of negative adaptations to its environment if it is to persist. This, we submit, is a

[2] Unpublished lecture.

fundamental principle for biology in general as well as for ecology; it must hold for the biotic community as a unit as well as for the individual or the species.

Certain environmental adjustments are apparently adaptive, for example, Bergmann's rule that related warm-blooded animals tend to be smaller as one approaches the tropics and the related rule of Allen that the appendages of such animals tend to be smaller the colder the climate. The rule of Gloger, that animals in warm humid regions tend to be more melanic than those in arid or in cool climates, is not so obviously adaptive. In this respect there is resemblance to Jordan's rule of the relation between numbers of vertebrae of fishes and temperature. The general principle of environmental induction that finds a striking demonstration in the determination of the fundamental organization by environmental action on the eggs of *Fucus* is more plainly adaptive, as is the widespread principle of convergence and of generalized mimicry which, in fact, may be merely a special instance of convergence.

The community concept is frequently thought of as being the only major ecological principle, an idea with which we do not agree. The self-evident individuality of animals makes equally self-evident the fact that individual animals have environmental relations with their physical environment as well as being immersed in a biotic community; hence the community, while important, is not all-important in ecology. All animals live in communities which include plants as well as other animals. These biotic communities range from those primarily integrated by environmental action, the so-called ecofaunae of Uvarov and ecoflorae, through the less closely knit biocoenoses to the truly social groups. Within all sorts of communities, animal aggregations may exist as more or less dense, more or less temporary collections of the same or of different species.

From the fact that animals live in communities it follows, even without the recent laboratory analyses of increased survival values that are frequently shown by aggregated animals, that there must be certain cooperative relations between organisms. This does not refute the obvious point that organisms also interact with each other to their disadvantage as well as to their advantage. The word cooperation has picked up certain engrafted meanings; basically it signifies working together and in this sense, as unconscious cooperation or automatic mutualism, it is one of the important integrating forces in community life. Much of the significance of this fact has long been recognized in the literature concerned with symbiosis in its various degrees from commensalism through mutualism and the truly social phenomena.

The gregarious habit also gives rise to generalizations which may be basically biotic or may grow out of relations with the physical environment. Thus there is a tendency for the animals at the base of food-pyramids to be gregarious and for the predators at their apices to be solitary. Also the larger animals in monotonous physical habitats tend to be more gregarious than are similar forms in strongly dissected habitats.

Communities have internal, spacial and temporal organization. Within the community there are various degrees of influence, which range from marked dominance to incidental or accidental forms. The organization in time introduces ecological succession or community evolution, which proceeds as a result of both biotic and of physical causes and which is essentially predictable. There is also the process of maturation of the community without evolution during which the pioneer forms develop to a mature stage of the community in question without ecological succession taking place. Community evolution tends towards a climax. This may be local, or as a biotic formation may be geographic in extent and composed of similar but slightly different associations or other less important units which are determined primarily by the dominant organisms but which may be recognized at times by differences in other influential constituents.

Communities are organized about the web-of-life relationships which include such factors as the utilization of environmental niches. In this connection, particularly with the vertebrates, there is a whole set of principles connected with territory, migration and with breeding, shelter and feeding ranges. These include such ideas as those connected with habitat "selection," as for example Hopkins' host selection principle and the concept of a "forced selection of habitat." The web-of-life is also concerned with food chain, food web and food pyramid relationships.

A quantitative approach to communities introduces the problems and theories concerned with longer cycles and with biotic balance or unbalance. To our way of thinking it is solely a matter of point of view whether we regard the community as being in the state of balance implied by the concept of dynamic equilibrium or think of it as being in perpetual unbalance. Both express the same general idea. It is significant that the periodic fluctuations in numbers may be conditioned by biotic interrelations as emphasized by the equations of Lotka and Volterra and/or by long-range environmental disturbances which may be either mundane or extra-mundane in origin. To sum up these relationships succinctly, they may be the result of the interplay of biotic potential, meaning the rate of increase, checked by environmental resistance which may be primarily an effect of the physical or of the biotic elements in the environment or of both acting together. We put the same idea into entirely biotic terms when we speak of the ratio between birth rate and death

rate. Under many conditions these quantitative aspects of population growth are well summarized by the logistic curve of Verhulst and Pearl.

The increased crowding of animals often results in harm to the animals involved. This may produce a lowered survival and even extinction. This is one phase of the modern concept of the struggle for existence which is essentially a statistical principle and deals with changes in the birth-death ratio.

By the interaction of automatic cooperation and competition, that is through the activities involved in the struggle for existence, we come upon a whole set of ecological principles that center about organic evolution. This is a field which many modern ecologists appear to have avoided. All the factors of natural selection, *e.g.*, variation, overproduction, struggle for existence and the survival of the fittest are definitely ecological except for the important matter of the origin of those crucial variations which are not environmentally induced. At this one strategic point genetics has its only distinctive claim in the whole of the evolutionary field; otherwise, evolutionary dynamics belong in the realm of ecology.

Almost all other evolutionary principles are also ecological in nature: Lamarckian use and disuse, if these ideas have any place in modern thinking, Buffonian induction, orthogenesis in part and orthoselection wholly, and of course all isolation whether geographic, ecologic or physiologic in character. Subsidiary evolutionary theories such as sexual selection, mimicry and adaptive radiation are also wholly or mainly ecological.

Ecology deals not only with individuals and with communities of these individuals; it is concerned also with species and with their relations. This widespread, useful concept is in part an ecological tool and in part an expression of ecological forces. Among the ecological principles related to species there is another important rule of Jordan's that the nearest ally of a given species tends to occupy an adjacent area. This may be expanded to state that related and neighboring species tend to occupy separate niches and hence are in less direct competition than they would be otherwise. Stated with slightly different emphasis this takes consideration of the fact that the closest competitors of a given individual are the members of its own species; this forms the basis of territorial relationships such as have recently been much discussed, particularly among birds. The next closest competition for the individual comes from members of closely related species with similar ecological requirements. Hence related species find greater stability in their community relations if they occupy separate niches.

There is another set of principles that concern us which center about geographical distribution. Among these there is the generalization that vigorous species tend to occupy more space the greater their age; this is generally known as the age and area hypothesis and has limited application. Related to this is the extension that old races on the road towards extinction tend to be locally distributed over wide areas. Another related principle is the depth-age formulation of A. Agassiz, which states for oceanic life that forms with the greatest range in depth are those that show the greatest span in time. Among other principles of geographic ecology there is the tendency of the animals in the Arctic to resemble those in the Antarctic. This is usually called the principle of biopolarity. There is also the tendency for tropical oceanic communities to have fewer individuals per species as contrasted with the large numbers of individuals of the same species in colder waters. The fundamental principle of the relative stability of the present ocean basins, which limits our ideas concerning the extent and importance of land bridges, although still a matter of discussion, seems to be reasonably well established.

Then there are the principles related to emigration or dispersal, among which may be mentioned the suggestion of Matthew and Griffith Taylor that primitive animals tend to be located in remote corners of the world far from their centers of origin. Under other conditions, the primitive forms are located in the center of distribution which may or may not also be a center of origin and a center of survival.

In conclusion we recognize the inadequacy of the present presentation. We have not listed all those principles known to us as definitely ecological, and the selection has been uneven in quality. Possibly more relatively unimportant principles have been included than important ones omitted. Even this brief summary indicates that, plentiful as are the facts, there is no dearth of major and minor ecological principles about which to orient them. We trust that the analysis here presented and which may be elaborated in the future may contribute toward a more adequate synthesis of ecological knowledge. We believe that focusing attention on a theoretical framework will lead to more important work in ecology.

OBITUARY

STUART T. DANFORTH
1900–1938

ORNITHOLOGISTS, entomologists and naturalists who have visited Puerto Rico in the past dozen years will mourn the death of Dr. Stuart T. Danforth, which occurred at West Boylston, Mass., on November 25. Going to Puerto Rico soon after his graduation from Rutgers in 1921 to visit his father, Ralph E.

Danforth, who was professor of biology at the College of Agriculture at Mayaguëz at that time, he commenced observations on the birds of the Cartagena Lagoon, which, supplemented by more intensive work in 1923–1924, constituted the field work of his doctorate thesis for which the degree was granted by Cornell in 1925. After a year as instructor in biology at Temple University, he succeeded his father at Mayaguëz, and has taught zoology and entomology there since. In connection with his teaching he continued constantly studies and collections of birds and insects, especially Coleoptera, and studies in the food of birds, not only in Puerto Rico, but also in Hispaniola, Cuba, Jamaica and the Lesser Antilles, especially in those areas and islands most difficult to reach. His vacations were always thus occupied, except when he came to the United States to work in libraries and museums in connection with his various finds. Ordinarily one or more of his students accompanied him on his trips.

"The ultimate aim of ornithology, to my mind, is to make use of birds to the limit of their capacity as servants of man. I believe that eventually we will know so well how to encourage and protect birds that they will be practically one hundred per cent. efficient in protecting our forests and crops from insect pests, and that poisonous sprays and other protective measures will be unnecessary in the vast majority of cases." From this statement, one can possibly understand how it happened that he published no entomological papers, although the large number of "Danforth" and "AMC (Agriculture and Mechanics College)" records in "Insectae Borinquensis" testify to the extent of his insect collections in Puerto Rico and to his generosity in making them available for publication in another's compilation. Nearly every year, however, marked the appearance of a technical paper on the birds of one of the Lesser Antilles, but the culmination of all his ornithological observations in the West Indies was the publication in 1936 of the illustrated "Los Pájaros de Puerto Rico," a handbook supposedly for school children, but actually including all the information available; a most fitting summary of his chosen life-work. Some years ago he presented a collection of bird skins to Cornell, while the remainder of his extensive collection was given to the United States National Museum.

GEORGE N. WOLCOTT

RECENT DEATHS AND MEMORIALS

DR. RAYMOND A. PEARSON, since 1935 special assistant to the administrator of the United States Farm Security Administration, previously from 1926 to 1935 president of the University of Maryland, died on February 13 in his sixty-sixth year.

DR. WILTON EVERETT BRITTON, state entomologist of Connecticut since 1901 and head of the department of entomology of the Agricultural Experiment Station at New Haven, died at New Haven on February 15. He had celebrated his seventieth birthday on September 18 but continued at the station until he became ill a few weeks ago.

GEORGE CHARLES EMBODY, professor of agriculture at Cornell University, died on February 17. He was sixty-two years old.

DR. IVAN C. JAGGER, senior pathologist in the Bureau of Plant Industry of the U. S. Department of Agriculture, died on February 16. He was in his fiftieth year.

DR. J. C. FLIPPIN, professor of clinical medicine and dean of the Medical School of the University of Virginia, died on February 16 at the age of sixty-one years.

CHARLES RICHARD CRANE, manufacturer of Chicago and active in the diplomatic and political history of the United States, died on February 15 at the age of eighty years. Mr. Crane was known to the biologists of the country for his part in the development of the Marine Biological Laboratory at Woods Hole, where he had a summer residence.

ARTHUR SMITHELLS, from 1885 to 1923 professor of chemistry at the University of Leeds and from 1923 to 1937 director of the Salters Institute of Industrial Chemistry, died in London on February 8 at the age of seventy-eight years.

SIR ROBERT WILLIAM PHILIP, of Edinburgh, who was knighted in 1913 for his work in connection with tuberculosis, died on January 26. He was eighty-one years old.

Nature reports the death of Paul Séjourné, free academician of the Paris Academy of Sciences, who was known for his work on the design and structure of bridges, aged eighty-seven years, and of Professor Josef Simon, professor of roentgenology and radiology in the Masaryk University, Brno, aged forty-one years.

THE hundredth anniversary of the death of Josiah Willard Gibbs, who was born on February 11, 1839, was commemorated by Yale University on February 16 with a memorial lecture by Dr. Charles A. Kraus, research professor of chemistry at Brown University and president of the American Chemical Society. Gibbs, regarded by many as the greatest American scientific man, was born in New Haven in 1839 and was professor in Yale University from 1871 until his death in 1903.

SCIENTIFIC EVENTS

ARCHEOLOGICAL WORK OF THE UNIVERSITY OF NEBRASKA FOR 1938

THE field season of the Archeological Survey of the University of Nebraska was drawn to a close the first part of December. Through the cooperation of the Works Progress Administration work was conducted on a much larger scale than previously.

Three parties were in the field. One party, at O'Neill, excavated a group of eleven mounds containing both cremated and bundle burials, with pottery of the "Woodland" type and stemmed projectile points. After completing the work at O'Neill the party moved to a site south of Lynch, at the mouth of Redbird Creek, a tributary of the Niobrara. The site consisted of house pits, of the circular type, with pottery and artifacts almost identical to those found in a previous year at a historic Ponca village near Verdel. One unique characteristic of the pottery is tempering of burned and crushed bone. A preliminary report on Ponca archeology will be available next spring.

Another party worked at Stanton, near the Elkhorn River. This site consisted of circular house pits with artifacts similar to those of the Oneota culture and a profuse amount of European trade goods. No documentation in reference to this site has yet been found. We request the aid of experts to identify and date trade beads, porcelain ware, glass bottles and gun parts found in this site. After completion of this site the party worked in one of the many nearby Upper Republican sites.

A third party, at Ponca, first excavated a new focus of the Nebraska culture, and then moved to a "Woodland" site in the same locality. The site was in an old terrace remnant and consisted of three distinct culture strata separated by 32" and 24", respectively, of sterile soil. While the pottery of all the strata was of the "Woodland" type it showed a distinct evolution from a thick, crude ware at the bottom, to a fine, thin and well-finished ware at the top. The day that the project was closed a fourth stratum was located. Work on this important site will be continued next year.

EARL H. BELL

NATIONAL PARKS

IN connection with the proposal to make the Kings River Canyon of California a national park, Secretary of the Interior Ickes has made public a statement in which it is recommended that Congress establish and set standards for wilderness national parks, in which roads would be limited by law and from which hotels would be excluded. The statement follows:

In 1935 I issued a statement of policy, declaring the purpose of the department, if this national park is authorized by Congress, to treat it as a primitive wilderness, limiting roads to the absolute minimum, maintaining foot and horse trails, excluding elaborate hotels, admitting all responsible packers, promoting good fishing, endeavoring to restore such nearly vanished wild life as the Sierra bighorn, the southern wolverine and the Pacific fisher; also to respect all valid existing equities, make every effort to conserve the watershed and recreational values of the region, and seek boundaries which will attain these ends without infringing upon the future development of the Kings River, for water storage, power and other uses, necessary to the welfare of the people of the San Joaquin Valley.

These principles of administration I wish to reaffirm. Since 1935, the Olympic National Park has been established and most of the lands have been acquired for the authorized Isle Royale National Park. Both will be maintained as wilderness areas. The problems of administration arising in connection therewith, and the questions arising in connection with the proposed Kings Canyon National Park, point to the need for a greater stability of policy than can be insured by administrative orders. Areas dedicated as wilderness national parks should be protected forever by provisions of law designed for that purpose, this in addition to the protection all national parks receive by law against commercial activities.

I shall welcome it if the Congress of the United States will define and set standards for wilderness national parks, as well as provide for wilderness areas to be proclaimed and similarly protected by law in other national parks. I suggest the following statutory safeguards for the Kings Canyon National Park if and when it is established:

1. Prohibit by law the building of any roads or truck trails in the park, except on the floor of the valley of the South Fork of the Kings River, below its junction with Roaring River.
2. Require that all buildings in the park shall be erected with government funds.
3. Exclude all public housing structures, except trailside shelters, from the park, except in the valley of the South Fork of the Kings River below Roaring River, allowing in that area simple cabins which may be rented to visitors, but not leased.
4. Permit public and private packers to use the park without discrimination, subject to general regulations.
5. On account of the relative absence of automobile roads, provide that the existing Sequoia-General Grant automobile fee shall admit to Kings Canyon.

By these policies, written into law, the Kings River wilderness can be maintained forever in its present grandeur, and dedicated to recreational use consistent with its wilderness aspect.

THE ANNUAL REPORT OF THE DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

DR. WILLIAM J. ROBBINS, director of the New York Botanical Garden, in his first annual report calls spe-

cial attention to the completion of the reconstruction of the main observatory, the establishment of a new laboratory for the study of vitamins and their functioning in the growth of plants, and the addition of more than 45,000 specimens to the herbarium among the achievements of 1938.

Figures collected in various departments indicate that the public had made greater use of the garden in the past year than at any time in recent years. Record crowds have visited the plantings both outdoors and in the newly reopened conservatory, and more people than usual have registered for gardening courses and attended the free Saturday lectures. On a single holiday, for example, 8,500 people viewed the perennial border, while 2,000 strolled through the Thompson Memorial Rock Garden, many of them taking notes on the plants which especially interested them, and on the same day, 2,500 persons walked through the three houses which were then open in the conservatory, examining the collection of cacti and other succulents.

For next year's displays, 2,500 tulips have been planted in the conservatory court, and 7,600 biennials are being raised for later bedding effects there. One hundred new varieties of iris in bearded, bulbous, Japanese and Siberian types, besides 15 natural species, totaling nearly 2,000 plants, are being added. During the past year, the Thompson Memorial Rock Garden has been enriched by 1,300 plants which were propagated by the garden, plus 450 received from other sources. Five thousand new bulbs have been planted there for an additional spring display. In the glade 300 lilies and 150 other plants have been set out for naturalizing. These plantings mark the beginning of the flowering meadow being created there. East of the rock garden, in the woods, a native flower area is being developed, and to this 500 plants were added during the year.

The department of plant pathology, under Dr. B. O. Dodge, has succeeded during the past year in reducing the infections of the Japanese beetle, the gipsy moth and the Dutch elm disease at the garden. Other scientific work includes work in genetics being done under the direction of Dr. A. B. Stout, including the development, in collaboration with the New York Agricultural Experiment Station at Geneva, of hardy seedless grapes for the northeastern states. The work on vitamins and plant growth is being directed by Dr. Robbins himself.

The herbarium, which now numbers 1,933,506 specimens, has been used during the past year by visiting botanists from thirty-four institutions in this country and abroad. In addition, collections of plants have been identified for botanists in eleven foreign countries and thirteen states, and loans have been made for study to the extent of nearly 15,000 specimens, sent to institutions in twenty-one states and seven foreign countries.

The library, under Miss Elizabeth Hall, with Dr. J. H. Barnhart as bibliographer, has been consulted this year by botanists and horticulturists from more than thirty states, territories and possessions and from nineteen foreign countries representing every continent. In addition, students from more than a hundred schools, colleges and institutions have used the library during the year, some for only a day but others for several weeks or longer.

Officers of the New York Botanical Garden, all of whom were reelected at the annual meeting, are Joseph R. Swan, *president;* Henry de Forest Baldwin and John L. Merrill, *vice-presidents;* Henry de la Montagne, *secretary;* and Arthur M. Anderson, *treasurer.* Mrs. Harold I. Pratt was elected to the board on January 12. Dr. E. C. Auchter, chief of the U. S. Bureau of Plant Industry, became a member just before the close of the year.

A CENTER FOR MATHEMATICAL ANALYSIS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE establishment of a center of mathematical analysis to direct the use of new types of calculating machines at the Massachusetts Institute of Technology has been made possible by a grant of $45,000 by the Carnegie Corporation of New York.

The center of mathematical analysis is being founded primarily for the purpose of encouraging and assisting technological advance in all fields by making available to scientific institutions and industry the means of carrying out intricate mathematical processes economically. The center will also carry out an active development program on new machines and the analytic methods of using them.

Recommended by the Committee on Scientific Aids to Learning of the National Research Council, the project includes the organization of a staff to operate the various machines developed at the institute. The program is to be centered in the department of electrical engineering in the new Rogers Building under the direction of Professor S. H. Caldwell.

As the scope of science and engineering has been developed and extended, the problems arising have increased in complexity and the associated mathematical labor has grown proportionately. Ordinary methods of analysis have either failed completely to keep up with this development or have given results only at the expense of much tedious routine computation. By means of the more recently developed types of machines, direct attack on problems is frequently possible and the routine labor is eliminated.

Equipment which will be available for use through

the center of mathematical analysis will include the original differential analyzer and a new, larger, faster and more accurate differential analyzer which is now under development at the institute, both of which make possible the solution of many difficult problems involving differential equations and integrations; the cinema-integraph; the network analyzer; the simultaneous calculator; a group of punched-card machines and miscellaneous types of commercial and special machines.

Organization of the center will be started at once and it is expected to be in operation next fall.

IN HONOR OF HAVELOCK ELLIS

THE following statement commemorating the eightieth birthday of Havelock Ellis on February 2 has been signed among others by Professor John Dewey, of Columbia University, and by Professor Adolf Meyer, professor of psychiatry of the Johns Hopkins University.

Havelock Ellis was born eighty years ago, on February 2, 1859, in Surrey, England, the son of a British seaman, and the last of a long line of English clergymen, mariners and merchants. Though Ellis is known for the wide range of his culture and interests, for his distinction as critic and writer, for his rare personal charm, and for his broad humanity, he will perhaps be best and longest remembered for the work to which, at an early age, he had dedicated his life and energy—that of bringing human sex psychology within the scope of science. His seven monumental volumes of "Studies in the Psychology of Sex" have probably served more than any other single work to bring sex out of the atmosphere of ignorance and prudery into the clear light of science, and will always remain an incomparable critical digest of the scientific knowledge of the subject up to contemporary times.

The scientific study of sex is nowadays accepted almost without question, but the destruction of the old taboos and prejudices was not accomplished without hardship and sacrifice. The appearance of Ellis's first volume of the Studies in 1897 was followed by a prosecution for the distribution of what the judge described as a "filthy publication." The sale of the book was suspended in England, but it is a matter of pride to American scientists that the Studies could thereafter be published in this country. "I am a student," wrote Ellis in his memorable Note on the Bedborough Trial, "and my path has long been marked out. I may be forced to pursue it under unfavorable conditions, but I do not intend that any consideration shall induce me to swerve from it." His life achievement is the best testimony to the success of this early resolve.

We hope that Havelock Ellis will for many years continue to exercise his great and good influence. His life and work remain an inspiration not only to us but to future generations as well.

AWARDS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

AT the annual dinner on February 15 of the American Institute of Mining and Metallurgical Engineers the William Lawrence Saunders Medal for distinguished achievement in mining was presented to Louis Shattuck Cates, copper-mining engineer and president of the Phelps Dodge Corporation. The award to Mr. Cates was "for signal accomplishment in the conception and application of superior mining technique and in the organization and administration of major mining and metallurgical enterprises."

The Robert Woolston Hunt Award was presented to Professor John Chipman, of the Massachusetts Institute of Technology, and Kenneth C. McCutcheon, of the American Rolling Mill Company, Ashland, Ky., for their paper on "Evolution of Gases from Rimming Steel Ingots."

The Institute of Metals Division Award for 1939 was presented to Assistant Professor Frederick N. Rhines and Robert F. Mehl, director of the metal research laboratory, both of the Carnegie Institute of Technology, Pittsburgh. The award was for their paper on "Rates of Diffusion in Alpha Solid Solutions of Copper."

The Alfred Noble Prize, for a paper by an author under 31 years old, was presented to Ralph J. Schilthuis, of the Humble Oil and Refining Company, Houston, Texas, for his paper on "Connate Water in Oil and Gas Sands."

Daniel Cowan Jackling, president of the institute, was toastmaster. Donald B. Gilles was inducted as president of the institute for 1939. The dinner was attended by approximately 1,200 persons.

SCIENTIFIC NOTES AND NEWS

THE seventy-sixth annual meeting of the National Academy of Sciences will be held in Washington on April 24, 25 and 26. The first lecture to be delivered in America under the Pilgrim Trust will be given by Sir William H. Bragg, president of the Royal Society, on Monday evening, April 24, at 8:30 P.M. Dr. Irving Langmuir, of the Research Laboratories of the General Electric Company, gave the corresponding lecture in London on December 28. The Pilgrim Trust, established in England by Edward S. Harkness, provides funds for the exchange of lecturers on alternate years between the National Academy of Sciences and the Royal Society.

DR. FRANK SCHLESINGER, director of the Yale University Observatory, has been elected foreign correspondent of the French Bureau des Longitudes, in succession to the late George Ellery Hale.

ROCKFORD COLLEGE, Illinois, conferred on February 18 the honorary degree of doctor of laws on Dr. Frank B. Jewett, president of the Bell Telephone Laboratories. The degree ceremony preceded the Maddox Foundation lecture given by Dr. Jewett, which was entitled "Changes in Society brought about by Science."

DR. ELMER V. MCCOLLUM, since 1917 professor of biochemistry at the School of Hygiene and Public Health of the Johns Hopkins University, has received the annual award of the Associated Grocery Manufacturers of America for outstanding contributions to the scientific knowledge of foods.

DR. DAVID FAIRCHILD, collaborator of the Division for Plant Introduction of the U. S. Department of Agriculture, was presented at a luncheon given on February 12 at the Hotel Astor, New York City, with one of the four annual awards of the American Booksellers Association for his autobiography entitled "The World was My Garden."

THE Paul Fourmarier Prize and gold medal of the Royal Academy of Belgium has been awarded to M. L. Cayeux, member of the Paris Academy of Sciences, honorary professor of geology at the Collège de France.

M. GASTON LOUIS RAMON, sub-director of the Pasteur Institute of Paris, has been made a Commander of the Legion of Honor for his work on immunization against diphtheria and tetanus and combined inoculations.

DR. MAX DESSOIR, professor of philosophy at the University of Berlin, celebrated the fiftieth anniversary of his doctorate on February 2.

DR. SAMUEL J. RECORD, professor of forest products at Yale University, has been appointed dean of the School of Forestry. He will succeed Dr. Henry S. Graves, who will retire from active service at the end of the college year after serving as dean of the school and Sterling professor of forestry since 1922. Dr. Graves has been a member of the faculty of the university for thirty-one years and was provost from 1923 to 1937.

THE title of emeritus professor has been conferred on Professor E. S. Salmon, formerly university professor of mycology at the South-Eastern Agricultural College, London, and on Professor P. G. H. Boswell, who has retired from the chair of geology in the Imperial College of Science and Technology.

THREE new professorships have been established at the Rensselaer Polytechnic Institute at Troy, N. Y.: the Russell Sage professorship of mechanical engineering, to be filled by Edwin Allan Fessenden; the Robert W. Hunt professorship of metallurgical engineering, to be filled by Matthew Albert Hunter, and the William Weightman Walker professorship of geodesy and transportation, to be filled by Howard Oakley Sharp.

DR. JOHN A. HARTWELL, past president of the New York Academy of Medicine, who will resign as director of the academy on April 1, has been appointed associate director of the American Society for the Control of Cancer.

DR. AARON J. ROSANOFF, since 1923 member of the Los Angeles County Lunacy Commission, has been appointed director of the state institutions of California.

DR. JAMES D. HARDY has been promoted to the position of research associate in the Russell Sage Institute of Pathology.

L. BRYANT MATHER, JR., has been appointed assistant curator of mineralogy at the Field Museum of Natural History.

DR. PAUL HERGET, of the Observatory of the University of Cincinnati, has become a member of the commission on minor planets, comets and satellites of the International Astronomical Union. He will aid the commission in the computation of the orbits of asteroids.

DR. LOUIS A. JULIANELLE, in charge of trachoma research at Washington University, St. Louis, will leave shortly for the Navajo reservation in Arizona and New Mexico to resume his study of the eye disease among the Indians. The Commonwealth Fund has supported the research for ten years.

PROFESSOR W. F. C. FERGUSON, who had leave of absence from the department of physics of the Washington Square College of New York University, has returned to New York from the University of California, where he has been carrying on research on band spectra.

ON the evening of February 7, the Royal Society, London, combined with the British Academy to give a reception to the exiled scholars and scientific men now under the care of the Society for the Protection of Science and Learning (the late Academic Assistance Council). The guests were received at Burlington House by Sir William Bragg and Sir Frederic Kenyon, and the Archbishop of York replied to the welcome on their behalf. On February 8 at Cambridge, the vice-chancellor of the university presided at a meeting addressed by Earl Winterton and Professor A. V. Hill. On February 10 at Oxford the vice-chancellor of the university presided at a meeting addressed by Viscount Samuel and Sir John Hope Simpson. Sir William Bragg spoke at Liverpool and Sir Henry Dale at Glasgow.

THE following members have been appointed by the Scottish Advisory Committee on Cancer: William James Stuart, *chairman;* Geoffrey Balmanno Fleming, Henry Lumsden Forbes Fraser, Alexander Stuart Murray Macgregor, David Robertson, John James McIntosh Shaw, William James Stuart and A. J. Purves, *secretary.* The committee has been set up to review existing facilities for the diagnosis and treatment of cancer, to recommend what developments are desirable, and to suggest how far and in what groupings local authorities could with advantage act together in securing that arrangements for diagnosis and treatment are adequate for the needs of their areas.

THE British Minister of Labor has appointed an advisory council, with Sir Walter Moberly as chairman, to advise him on the utilization in war-time in government departments or elsewhere of persons with scientific, technical, professional and the higher administrative qualifications. Among those who have accepted membership are: H. L. Eason, principal of the University of London; Sir Edward Mellanby, secretary of the Medical Research Council, and Professor A. V. Hill, Foulerton research professor of the Royal Society, London.

THE twenty-seventh course of Lane Lectures at Stanford University will be given from May 22 to 26 by Dr. Thomas M. Rivers, director of the Hospital of the Rockefeller Institute for Medical Research. The general title for the series will be "Viruses and Virus Diseases."

DR. HERBERT J. SPINDEN, of the Brooklyn Museums, delivered the eighth Arthur Lecture under the auspices of the Smithsonian Institution in the U. S. National Museum on February 21. He spoke on "Sun Worship."

DR. ROY GRAHAM HOSKINS, director of research at the Memorial Foundation for Neuro-Endocrine Research at the Harvard Medical School, gave the Laity Lecture on February 9 at the New York Academy of Medicine. His subject was "The Story of Mental Diseases."

THE fifty-fifth annual meeting of the American Association of Anatomists, by invitation of Harvard University, Boston University and Tufts College, will be held in Boston at the Harvard Medical School, on April 6, 7 and 8. Arrival on the evening of April 5 is suggested for an informal social meeting at the headquarters, the Hotel Somerset, or at the Boston Medical Library near by, where rare early anatomical works will be exhibited. The American Association of Physical Anthropologists will conclude its session at the Wistar Institute on April 5, making it as convenient as possible to attend both the Philadelphia and Boston meetings.

THE hundredth anniversary of the discovery of the cell was commemorated by a meeting of the Section on Medical History of the College of Physicians of Philadelphia on February 13. From the School of Medicine of the University of Pennsylvania, Dr. W. H. F. Addison, professor of histology and embryology, spoke on "Early History of the Discovery of the Cell"; Dr. E. B. Krumbhaar, professor of pathology, on "Rudolph Virchow and Cellular Pathology," and Dr. J. Harold Austin, professor of research medicine, on the "History of the Chemistry of the Cell." Dr. Ethel Browne Harvey (by invitation), investigator, department of biology, Princeton University, spoke on "Division and Development of Eggs without Nuclei." An exhibit illustrating the subject was open in the evening.

A CORRESPONDENT writes: "The Association Préhistorique des Amis des Eyzies is organizing a celebration in honor of M. Denis Peyrony upon his reaching the age of seventy years. The celebration will take place at Les Eyzies, Dordogne, France, on Palm Sunday, April 2, when a bronze medallion portrait of M. Peyrony will be unveiled at the Prehistoric Museum. American colleagues and admirers will be welcome at the ceremony. Those wishing to aid in this expression of esteem and of appreciation of all that he has achieved for prehistoric archeology in forty years of digging and research, as well as of his unfailing helpfulness and courtesy to American and other foreign archeologists visiting Les Eyzies and the caverns of Dordogne, may participate by sending a subscription which has been set at a minimum of 50 francs, equal at present to $1.35. Checks should be made to the order of H. H. Kidder, treasurer, Care Morgan and Company, 14 Place Vendome, Paris."

DURING the early expeditions of the American Museum into the Morrison Jurassic beds of the western United States, many large separate dinosaur bones, mostly sauropods, were collected, which subsequently have been represented by skeletons. It has become necessary to discard a considerable amount of this material which would have great teaching value to schools and colleges and much exhibitional value to institutions that display natural history objects. Most of these bones are in their original plaster of paris field wrappings, but could be prepared by recipients at a nominal expense. They include large limb bones, foot bones, ribs and vertebrae. Specimens will be sent gratis to schools and societies that will pay freight, drayage and the expense of boxing. This material is now available, and a list of specimens may be obtained by writing to Dr. Barnum Brown, American Museum of Natural History, New York City.

AT the eighth annual meeting of the Academy of Pediatrics in 1938, the offer of Mead Johnson and Company to establish the E. Mead Johnson Award for

Research in Pediatrics for a period of ten years was accepted. An academy committee on awards was appointed, consisting of: Drs. Joseph Brennemann, Chicago; Irvine McQuarrie, Minneapolis; Oscar M. Schloss, New York; Edwards A. Park, Baltimore, and Borden S. Veeder, St. Louis (*chairman*). The committee announces the following rules and regulations governing the award: Two awards, one of $500 and one of $300, will be given annually at the annual meeting of the Academy of Pediatrics; the awards will be made for research work published during the previous calendar year; there is no limitation as to the type or scope of the research except that it be in the field of pediatrics; the award is limited to workers in the United States and Canada; the award shall be limited to investigators who have been graduated not more than 15 years previous to the publication of the research; there is no restriction as to the journal of publication of the research. The award in 1939 will be given for research published during the period January 1, 1938, through December 31, 1938, by a graduate of 1923 or later. The award in 1940 will be given for research published January 1, 1939, through December 31, 1939, by a graduate of 1924 or later, and so on for subsequent years.

THROUGH the bequest of the late William Campbell, for many years Howe professor of metallurgy at Columbia, there have been established the William Campbell fellowships, primarily for scientific research in the field of metals. These fellowships become available for the first time for the academic year 1939–40 for graduate study and research at Columbia University. They carry stipends up to $1,200 per annum as determined by the Campbell Fellowship Committee. Applications accompanied by certified transcripts of academic records, proposed research projects and proposed fields of graduate studies should be filed with the Dean of Engineering, Columbia University, New York City, before March 15.

THE Graduate School of the University of Illinois announces the establishment of four research fellowships to be awarded for one year in the fields of medicine and dentistry in Chicago at a stipend of $1,200 per year (calendar year with one month's vacation). Fellows are eligible for reappointment in competition with the new applicants. Candidates for these fellowships must have completed a training of not less than eight years beyond high school graduation. Applications should be made before March 1. Announcement of the fellowship awards will be made on April 1, becoming effective on September 1. Applications should be made before March 1 to the secretary of the Committee on Graduate Work in Medicine and Dentistry, 1853 W. Polk Street, Chicago, Ill.

ACCORDING to a correspondent of the *Journal* of the American Medical Association, the Association of Physicians in Poland has taken strong action to withdraw Jews from the medical profession. A deputation of the association appealed to the medical departments of all Polish universities not to admit Jews. The demands have been partially followed by the universities. The percentage of Jewish candidates admitted lately to the medical departments in all Poland amounts only to 3.7.

DISCUSSION

DO THE ISOTOPES OF AN ELEMENT HAVE IDENTICAL CHEMICAL PROPERTIES?

THE answer to this question has definitely changed in the last few years. For many years it has been erroneously concluded that the chemical properties of isotopic molecules were exactly identical in every respect. Text-books published within the last year even carry such statements. Many scientists engaged in other fields of research are not aware of recent developments which have changed the answer to this question. In view of recent theoretical calculations and important and dramatic successes in the separation of a number of isotopes by chemical means, our old concept will certainly require some modification. The isotopes of hydrogen, nitrogen, carbon, oxygen, lithium and potassium have all been shown, through fractionation by chemical means, to have small differences in their chemical characteristics.

Since all the isotopes of an element have the same atomic number, that is, the same number of external electrons, we expect them to have the same *kind* of chemical properties, but since the atomic mass is different, we may expect a small difference in the rate or extent to which certain reactions take place. This is what has been found to be true. After the discovery and separation of the hydrogen isotopes, these differences were abundantly verified. Since the mass of deuterium is twice that of hydrogen and since the energy content of their molecules is markedly different, we should expect differences to occur particularly in such properties as rate of reaction, equilibrium states, electrolytic separation and biological behavior. Differences in the rate or extent of various reactions have been found to be from a few per cent. to over a thousand per cent.

The failure for many years to achieve a separation of other isotopes by chemical means led to the erroneous conclusion that their chemical behavior must be

exactly identical. Some years ago it was pointed out on theoretical grounds that there should be small differences in chemical behavior, and in 1935 Urey and Greiff made calculations for a whole series of isotopic chemical exchange reactions, a number of which have been used in attempts to separate the isotopes of the lighter elements. Among the two-phase gas-liquid chemical reactions which Urey and his co-workers have succeeded in obtaining some fractionation of the isotopes are: (1) The reaction of ammonia gas with ammonium ion in solution; (2) the reaction of ammonia gas with solvated ammonia in water and in alcohol; (3) the reaction of sulfur dioxide gas with bisulfite ion in solution; (4) the reaction of carbon dioxide with bicarbonate ion in solution. In all these cases the heavier isotope prefers to form the ion and is therefore concentrated in the solution. In this respect the heavier isotope is slightly different chemically from the lighter isotope. The fractionation factors α, which in these cases are the same as the equilibrium constants, give a measure of the chemical differences and are as follows:

(1) $N^{15}H_3 + N^{14}H^+ \leftrightarrows N^{14}H_3 + N^{15}H^+$ $\alpha = 1.021$
(2) $N^{15}H_3 + N^{14}H_{3(aq)}^{4} \leftrightarrows N^{14}H_3 + N^{15}H_{3(aq)}^{4}$ $\alpha = 1.006$
(3) $S^{34}O_2 + HS^{32}O_3^- \leftrightarrows S^{32}O_2 + HS^{34}O_3^-$ $\alpha = 1.015$
(4) $C^{13}O_2 + HC^{12}O_3^- \leftrightarrows C^{12}O_2 + HC^{13}O_3^-$ $\alpha = 1.014$

These differences are of the order of 1 to 2 per cent. compared to 300 per cent. to 1000 per cent. for the electrolytic separation of hydrogen and deuterium. However, with sufficient repetition of these equilibrium stages in a counter-current system, appreciable separation of the isotopes can be achieved. By use of reaction (1) Dr. Thode, Dr. Urey and their co-workers at Columbia University have recently announced that they have increased the concentration of N^{15} from 0.3 per cent. to 73 per cent., a remarkable accomplishment and an important one particularly for biological studies.

Lewis and Macdonald, of the University of California, using a counter-current flow of lithium in a mercury amalgam and lithium chloride in an ethyl alcohol solution, increased the concentration of Li^6 from 8 per cent. to about 16 per cent. The Li^6 was preferentially held in the amalgam and in this respect is slightly different chemically from Li^7. A number of investigators, including the present author, have studied the electrolysis of lithium from salt solutions into flowing mercury electrodes. Differences in the rate of discharge of the isotopes ranging from 2 per cent. to 7 per cent. have been observed. These differences are very much smaller than for electrolytic separations of hydrogen and deuterium, but are indeed real.

The present author in collaboration with Dr. Urey has also succeeded in obtaining a small fraction of the lithium and potassium isotopes by chemical exchange with zeolites. Zeolites are complex alkali alumino-silicates commonly used in water softening. The alkali ion is replaceable by other positive ions, and one isotope of lithium, for example, replaces sodium better than the other:

$$Li^+ + Na\ Zeolite \leftrightarrows Li\ Zeolite + Na^+$$

The differences are again small, but by use of a 100-foot column, appreciable changes in the isotope ratio were produced. Further studies on these zeolite reactions and other similar reactions are being carried out at the University of Minnesota in attempts to obtain a larger separation of the biologically important and significant potassium isotopes.

It is indeed fortunate that the isotopes of an element all undergo the same *kind* of chemical reaction, otherwise their use in "exchange reactions" and "tracer" reactions would be impaired. By determining the extent to which a light isotope exchanges with a heavy isotope in contact with a molecule, one is in a position to say something about the binding or reactivity of the exchanging atoms. Groups containing the heavy isotope may be followed from one molecule to another in order to determine structure or reaction mechanisms. By synthesizing fats containing heavy hydrogen or carbon, or amino-acids and proteins containing heavy nitrogen or sulfur, or drugs or other chemicals, we may tag or label the molecule and trace it through biological processes. All we have to do is put it in the molecule such that it will not easily leave and exchange for the lighter isotopes. By analysis of different parts of the animal for the heavy isotope, we can determine where the substances fed or injected have gone. This is an example of a tracer reaction in biological chemistry, a very important new tool in the study of nutrition, biology and medicine.

We may conclude, therefore, that while the isotopic compounds of the lighter elements have a sufficient difference in chemical characteristics to afford a separation by chemical means (difficult as it may be), the differences are not sufficient to interfere with their valuable use in tracer and exchange reactions.

T. IVAN TAYLOR

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SPAWNING OF OSTREA VIRGINICA AT LOW TEMPERATURES[1]

SINCE the end of the last century it has been generally accepted among aquatic biologists that under natural conditions the eastern oyster (*O. virginica*) may spawn only when the water temperature reaches

[1] Published with the permission of the U. S. Bureau of Fisheries.

20.0° C. or higher (Townsend, Stafford, Churchill, Prytherch and others).[2, 3, 4, 5] These field observations were confirmed in the laboratory by Galtsoff,[6, 7] who stated that the results of his extensive experiments with *O. virginica* showed that no spawning occurred below 20.0° C. However, the writer's observations of the last two summers on the spawning of oysters in Long Island Sound indicate that spawning may take place at temperatures several degrees lower than the so-called critical temperature of 20.0° C. In 1937 the initial and general spawning of the oyster population of the Sound, living in water from 1 to 25 feet, took place on and about July 3. The date of spawning was ascertained by Mr. James Engle and the writer by the age of oyster larvae found in the water, by the time of the beginning of oyster setting and, chiefly, by gross and histological studies of oyster gonads. The last method provided infallible proof that the gonads of oysters were partly discharged. The bottom water temperature several days prior to and during spawning time ranged from 17.5 to 18.5° C.

In 1938 the first spawning of oysters occurred on June 28, far ahead of the expected time. At one of our stations located in 30 feet of water, half of the oysters examined were found with partly discharged gonads, although the highest bottom temperature recorded at that station prior to and at the beginning of spawning was only 16.4° C. The highest temperature recorded at any of our 15 sampling stations, distributed over a distance of 30 miles of the oyster-producing section of the Sound, was 18.3° C. The average bottom water temperature of all 15 stations was 17.0° C. To avoid any errors in recording, the water temperature measurements were taken simultaneously with four deep-sea reversing thermometers, their correctness verified by the U. S. Bureau of Standards. The temperature was read by two investigators. At the invitation of the writer, Dr. P. S. Galtsoff, of the U. S. Bureau of Fisheries, was present on the investigation trip on June 30 and confirmed the fact that oysters spawned at temperatures lower than 20.0° C.

The observations of the last two summers refute the method advanced by Prytherch[8] for predicting one month in advance the time of spawning. His method is based upon the assumption that the spawning of oysters can not occur at a temperature lower than 20.0° C. Evidently, some other factors, undetermined at present, are involved in inducing the spawning of oysters at low temperatures. Until these factors and their role in stimulating the shedding of sex cells can be ascertained, no infallible method for predicting the time of spawning of oysters living under natural conditions can be advanced.

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HANDEDNESS OF TWINS

THAT the members of an occasional pair of identical twins differ in unimanual handedness is a well-established fact. The reasons for such reversals, however, have long been a matter of controversy. Newman and his school believe such reversals occur in those pairs in which division of the embryo occurred relatively later in embryonic development than in those pairs in which no reversals are manifest. The supposition is that in the former instance certain irreversible developments have taken place prior to separation of the embryos, thus one resulting embryo would be similar to the right and the other to the left side of what would have been a single individual had no separation taken place. According to this system of reasoning, identical twins showing less similarity in general appearance should show more reversals in handedness and other bilateral traits. The above theory has met with considerable criticism by various students of twins, in that no significant correlation has ever been shown to exist between the general similarity in features and appearance and the degree of reversal in handedness.

For several years the writer has noted that in both identical and fraternal twins showing reversals in unimanual handedness, an apparently high percentage of such pairs have one or more left-handers among their immediate relatives. An opportunity to obtain a considerable amount of pertinent data was afforded the writer by an invitation to attend a recent[1] twin party at Waterville, Maine. The party was sponsored by Mr. Welton P. Farrow to celebrate the visit of his identical twin brother, whom he had not seen for nineteen years.

Close to two hundred pairs of twins attended the party. The finest cooperation was given to the writer and his assistants, and data were obtained on the unimanual handedness of 109 pairs of twins and their immediate families. These data, plus data previously obtained, were sufficient to permit a statistical analysis.

[2] C. H. Townsend, Rept. U. S. Fish. Comm. for 1889–91, 345–348.
[3] J. Stafford, Comm. of Conservation, Canada, 1–159, 1913.
[4] E. P. Churchill, Rept. U. S. Fish. Comm. for 1919, 1–51, 1921.
[5] H. F. Prytherch, Appendix 11, Rept. U. S. Fish. Comm., Doc. 961, 1–14, 1923.
[6] P. S. Galtsoff, *Collecting Net*, 4: 10, 277–278, 1931.
[7] P. S. Galtsoff, *Proc. Nat. Acad. Sci.*, 16–9, 555–559, 1930.
[8] H. F. Prytherch, *Bull. U. S. Bur. Fish.*, 44, 429–503, 1929.

[1] Held on August 16, 1938.

Out of a total of 82 pairs of identical twins alike in handedness, 19 pairs or 23.1 per cent. have one or more left-handed relatives in their immediate families. Out of a total of 20 pairs of identical twins showing reversals in handedness, 11 pairs or 55 per cent. have one or more left-handed relatives in their immediate families. The difference in the percentage occurrence of left-handed relatives of the two groups is 31.9 per cent. $\pm$ 11.37,[2] a significant amount.

Interestingly enough, the same type of analysis of fraternal twins gave strikingly similar results. Out of a total of 50 fraternal pairs having the same handedness, 9 pairs or 18 per cent. have one or more left-handers in their immediate families, whereas among fraternals showing reversals in handedness, 8 out of 14 pairs, or 57.1 per cent., have left-handers in their immediate families. Here the difference in the percentage occurrence of left-handers among the relatives of the two groups is 39.1 per cent. $\pm$ 14.09, again a significant difference.

These findings thus indicate conclusively in both types of twins that left-handedness occurs more frequently among the relatives of those pairs showing reversals than among the relatives of pairs alike in unimanual handedness. The most probable explanation would seem to be that handedness is a quantitative trait and that in embryos which are genotypically near ambidexterity, if twinning occurs, the unusual position in utero is sufficient to shift handedness one way or the other. We should naturally expect to find a higher percentage of such genotypes in families with left-handers. In fraternal twins, of course, we have somewhat different heredities in the members of a pair and might thus expect to find a higher percentage of reversals than in identicals, who have the same genotype.

In a total of 139 pairs of identicals, we found 22 pairs or 15.8 per cent. to have reversal in handedness, whereas in 81 pairs of fraternals, 18 pairs or 22.2 per cent. Thus, according to our data, reversals occur in 6.4 per cent. $\pm$ 5.3 more cases of fraternal than identical twins. While this difference is not sufficient to be statistically significant, it rather definitely refutes the contention of some to the effect that reversals in handedness occur more frequently in identical than in fraternal twins.

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"MANIFESTO" BY A PHYSICIST

MANY scientists must have been profoundly disturbed by the revelations of recent events as to what the implications of the totalitarian philosophy of the state really are. There would seem not to be room on the same planet for totalitarian states and states in which the freedom of the individual is recognized. Many scientists must have been moved to try to find something to do about it. In my own case this urge to find something to do has resulted in the decision to close my laboratory to visits from citizens of totalitarian states. I have had the following statement printed, which I hand to any prospective visitor who may present himself.

Statement

I have decided from now on not to show my apparatus or discuss my experiments with the citizens of any totalitarian state. A citizen of such a state is no longer a free individual, but he may be compelled to engage in any activity whatever to advance the purposes of that state. The purposes of the totalitarian states have shown themselves to be in irreconcilable conflict with the purposes of free states. In particular, the totalitarian states do not recognize that the free cultivation of scientific knowledge for its own sake is a worthy end of human endeavor, but have commandeered the scientific activities of their citizens to serve their own purposes. These states have thus annulled the grounds which formerly justified and made a pleasure of the free sharing of scientific knowledge between individuals of different countries. A self-respecting recognition of this altered situation demands that this practice be stopped. Cessation of scientific intercourse with the totalitarian states serves the double purpose of making more difficult the misuse of scientific information by these states, and of giving the individual opportunity to express his abhorrence of their practices.

This statement is made entirely in my individual capacity and has no connection whatever with any policy of the university.

Science has been rightly recognized as probably the one human activity which knows no nationalisms; for this reason it has been a potent factor making for universal civilization. Action such as this is therefore to be deeply deplored and to be undertaken only after the gravest consideration. But it seems to me that the possibility of an idealistic conception of the present function of science has been already destroyed, and the stark issues of self-survival are being forced upon us. Perhaps the only hope in the present situation is to make the citizens of the totalitarian states realize as vividly and as speedily as possible how the philosophy of their states impresses and affects the rest of the world. Such a realization can be brought about by the spontaneous action of the individual citizens of the non-totalitarian states perhaps even more effectively than by their governments. Here I think is one of the few conceivable situations in which the popular conception of the social "responsibility" of "science" can touch at all closely the individual scientist.

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[2] S.E. difference.

SOCIETIES AND MEETINGS

THE FIFTH WASHINGTON CONFERENCE ON THEORETICAL PHYSICS

THE theory of low-temperature physics was the focal point of discussion held in Washington from January 26 to 28 under the joint auspices of the George Washington University and the Carnegie Institution of Washington, acting through its Department of Terrestrial Magnetism. The properties of liquid helium and of liquid hydrogen and deuterium, the interpretation of data on the adiabatic demagnetization of paramagnetic salts at temperatures below 1° K and the phenomenon of superconductivity were the subjects discussed. In addition, the theory of certain very recent developments in nuclear disintegration of atoms and the theory of nuclear binding forces were discussed. Professors Niels Bohr, Harold C. Urey, Enrico Fermi, F. London, G. E. Uhlenbeck, J. H. Van Vleck, H. A. Bethe, G. Breit, E. U. Condon, I. I. Rabi, A. E. Ruark, F. Bitter, H. Grayson-Smith, F. Seitz, O. Stern, L. Rosenfeld and many other physicists active in research were present.

Certainly the most exciting and important discussion was that concerning the disintegration of uranium of mass 239 into two particles, each of whose mass is approximately half of the mother atom, with the release of 200,000,000 electron-volts of energy per disintegration. The production of barium by the neutron bombardment of uranium was discovered by Hahn and Strassmann at the Kaiser-Wilhelm Institute in Berlin about two months ago. The interpretation of these chemical experiments as meaning an actual breaking-up of the uranium nucleus into two lighter nuclei of approximately half the mass of uranium was suggested by Frisch of Copenhagen together with Miss Meitner, Professor Hahn's long-time partner, who is now in Stockholm. They also suggested a search for the expected 100,000,000-volt recoiling particles which would result from such a process. Professors Bohr and Rosenfeld had arrived from Copenhagen the week previous with this news, and observation of the expected high-energy particles was independently announced by Copenhagen, Columbia, Johns Hopkins and the Carnegie Institution shortly after the close of the conference. Professors Bohr and Fermi discussed the excitation energy and probability of transition from a normal state of the uranium nucleus to the split state. The two opposing forces, that is, a coulomb-like force tending to split the nucleus and a surface tension-like force tending to hold the "liquid-drop" nucleus together, are nearly equal, and a small excitation of the proper type causes the disintegration.

An interesting connection between nuclear physics and low temperatures, as pointed out by Professor Teller, is the fact that the balance between zero-point energy and potential energy is very similar in the liquid-droplet model of the atomic nucleus and in liquid helium-II. In fact, a similarity-transformation of linear dimensions by $1/10^5$ and energies by 10^{10}, in accordance with experiment, will transform the model of liquid helium-II into something very similar to the liquid-droplet model of the nucleus.

Professor Uhlenbeck introduced the discussion of the differences in the physical properties of the isotopic modification of hydrogen, H_2, HD and D_2 at low temperatures with a consideration of how these differences arise. Classical physics would lead one to expect that the equilibrium properties, that is, properties which do not involve the time explicitly, as for example, vapor-pressures and molecular volumes, should be independent of the molecular weight if the interatomic forces of atoms of H and D are alike. These forces for isotopic atoms are so nearly the same that it has been concluded that the differences in these equilibrium-properties of the isotopes must be the result of quantum-effects. Two essentially different quantum-effects arise. The first arises because the de Broglie wavelength of a gas molecule depends upon its molecular weight and at low temperatures becomes so large compared with the size of the molecule that the diffraction-effects of the de Broglie waves upon collision of gas molecules become important. This has an important bearing upon the equation of state of the gas and the differences between the virial coefficients of H_2 and D_2 may be accounted for upon this basis. The second class of quantum-effects arises because of the large differences between the zero-point lattice-energies. These are responsible for the large differences in the vapor-pressures, molecular volumes, triple points and heat-capacities of H_2, HD and D_2. Calculations based upon simple harmonic oscillators and the simple considerations of Debye's theory of the solid state have been able to account quantitatively for the observed differences in the properties. Professor London gave an account of the theoretical considerations of Mr. Hobbs and himself based upon a similarity of the intermolecular-force fields and high zero-point energies in condensed hydrogen and helium. Thus the hydrogen molecules are in effect contained in small volumes having a large confining force at the boundaries but only small forces in the interior. Calculations of the heats of vaporization of the solids and molecular volumes at 0° K are in agreement with the experimentally derived values. The anomalous character of the heat-capacities of the solid and liquid isotopes were discussed.

The differences in the properties of the ortho and para varieties of H_2 and D_2 were discussed. Dr. Karl Cohen, of Columbia University, outlined a theory developed by Professor H. C. Urey and himself to

account for the larger heats of vaporization and smaller molecular volumes of the rotating (j=1) varieties of H_2 and D_2. These differences in the properties of the ortho and para varieties arise because of the rotation of the ortho molecule. One important effect is that the centrifugal force resulting from the rotation stretches the inter-atomic distance in the molecule and in effect makes the rotating molecule larger.

Professor F. London, of the Institut Henri Poincaré of the University of Paris, who has been visiting professor at Duke University for some months, recently developed a theory which accounts for many of the phenomena observed in liquid helium at and below the "λ" transition point. As is well known, the phenomenon is such that the liquid helium does not become a solid upon lowering its temperature but, after passing through the λ point (sudden change of specific heat at 2.2 K), it becomes a superfluid having extremely low viscosity, a high heat-conductivity in the region of the λ point and other very strange effects such as the "fountain-effect" and an astounding ability to "creep" up the walls of containers and tubes are observed. London has proposed that this behavior is a condensation of the Bose-Einstein gas into the lowest energy-states. However, the liquid helium is not an ideal Bose-Einstein gas, since the effect of Van-der-Waals forces is to create some spatial order. This will give a decrease in the density of the levels for the lowest states (proportional to say k^4dk instead of k^2dk as for free particles, where k is the wave-number). It can be shown that such a non-ideal Bose-Einstein gas will have a jump in the specific-heat curve at the point where particles begin entering the lowest energy states. Professor London emphasized a possible analogy of the behavior of helium-II to the superconductivity-electrons in metals and to the diamagnetism observed in many types of solids. He also proposed a theory for the viscosity and heat-conduction of helium-II (bearing an analogy with electrons in a metal) which makes use of free particles obeying a Bose statistics. The work of L. Tisza on these phenomena was discussed; Tisza states that not all the atoms enter the lowest energy state and therefore a few of them have a finite momentum and exert a pressure. Only these few give rise to the viscosity which one observes; the heat-conduction arises from the change in pressure of these excited atoms. Professor Fermi and Professor London proposed several experiments which would throw further light on these problems.

Recent considerations bearing on the method of Giauque and Debye for obtaining temperatures below 1° K by the adiabatic demagnetization of a paramagnetic salt and the property of matter at these temperatures were discussed by Professor J. H. Van Vleck, of Harvard University. The well-known method of liquefying a gas such as helium consists in isothermally compressing (thus lowering the entropy of the system) and then expanding adiabatically (thus lowering the temperature while the entropy stays constant); magnetic cooling is quite similar—the magnet is the "entropy squeezer" and the field is released after establishing thermal insulation (pumping out the heat-transfer gas around the paramagnetic salt).

The experiments of Simon, Kurti and coworkers on $NH_4Fe(SO_4)_2 \cdot 12H_2O$ at temperatures below 1° K was discussed by Dr. M. H. Hebb and Dr. C. F. Squire. The absolute temperature scale was established in these experiments *not* by use of Curie's law relating the magnetic susceptibility with the temperature, but through the thermodynamic relationship $T_{abs} = \Delta Q/\Delta S$. The Curie law, which is valid at temperatures of 1° K, is no longer valid at the temperatures obtained by magnetic cooling because just the interaction forces which produce the cooling effect are responsible for the variation from Curie's law. Professor Van Vleck discussed the theory of these interaction forces—the splitting of electron-energy states by the crystalline electric field and the spin-spin interaction of the paramagnetic ions causing further splitting. Partition-functions and specific heats were calculated for several salts, and agreement with experiment indicates that a representation of the local field acting on the spins of the type proposed by Onsager is better than the classical one of Lorentz. Spin-spin interaction could only be partially solved and agreement with experiments remains only qualitative. The theoretical interpretation of the ferromagnetism (hysteresis effects) found in iron-alum by Simon and Kurti at 0.034 K remains quite unclear.

The theory of paramagnetic relaxation-time and the experiments of Professor Gorter and other Dutch physicists were discussed in great detail. Just as one has absorption and dispersion of the electric vector light, so one can have magnetic absorption and dispersion at about radio frequencies. The oscillators are the electron-spins, which are damped by the spin-spin coupling in about 10^{-9}/sec; the damping-time can be enormously increased by applying an external magnetic field. Under these conditions the spin-spin coupling is too weak to "finance a turn over" of the dipoles, but the spin-lattice interaction can turn them over.

The time required for spin-lattice interaction to establish thermal equilibrium has great significance, since it might be the limiting factor in reaching still lower temperatures than have been attained up to now. According to Van Vleck and Kronig, non-adiabatic coupling between lattice vibrations and electronic motion determines this time. Quantitative calculations are still in a preliminary stage. Relaxation-time between nuclear-spin moments and electron-spins or with the lattice are very long and the cooling to extremely low temperatures by this interaction would require at least a day before equilibrium would be established. Professor Teller discussed the calculation for the

time-effect. The matrix-element (perturbation-energy) which gives the transition-probability between the nuclear spin and electron-spin is quite small for paramagnetic salts. Perhaps the interaction with electrons in metals would be sufficient to cut down the relaxation-time considerably.

The theory of superconductivity was briefly discussed by Professor F. London. It must be emphasized that the magnetic behavior is as important as the superconduction. The microscopic picture is not yet clear. From the behavior of liquid helium and that of diamagnetism in solids it is probable that superconductivity is a cooperative phenomenon causing very low level-densities for low energies.

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REPORTS

THE BANTING RESEARCH FOUNDATION

THE annual report for 1937–38 of the Banting Research Foundation reveals that its income was, as usual, disbursed in two ways. A substantial part of it was placed at the disposal of Sir Frederick Banting to employ research workers in the Department of Medical Research, University of Toronto, to pursue research work of his election. This is allowing the investigation of twenty-one different problems in the department which Sir Frederick heads. The second, and slightly larger portion of the foundation's income, was widely distributed throughout Canada to twenty-four applicants who submitted problems to the foundation which met with the trustees' approval. These problems are being worked out in various hospitals and university laboratories scattered throughout the country. Analysis of the applications showed that they were granted to provide financial assistance for four different purposes: (1) salaries for full-time work, (2) salaries for part-time work, (3) salaries for helpers or assistants and (4) money for equipment and materials only. Following is a list of these workers whose applications were granted during the past year, the place where the work is being carried out and the general topic with which each problem is concerned.

B. F. Crocker, department of biochemistry, University of Toronto, is making an experimental study of digestion. E. W. McHenry, school of hygiene, University of Toronto, is studying the physiological action of vitamin C. R. W. Begg, department of pathology, Dalhousie University, Halifax, is making an extensive study of the sedimentation of erythrocytes. E. M. Boyd, department of pharmacology, Queen's University, Kingston, is pursuing further studies on the water-balance hormone of the pituitary. Maria Sergeyeva, department of physiology, McGill University, is investigating the nervous and hormone effects on the structure of islet cells. B. Rose, University Medical Clinic, Royal Victoria Hospital, Montreal, is studying the effect of cortin and histaminase on the disappearance of histamine in the adrenalectomized rat. M. J. Miller, University of Saskatchewan, is determining the distribution of human parasites in midwestern Canada. G. L. Bateman, department of physiology, Queen's University, is investigating the occurrence and function of acetylcholine in the placentae of animals. E. A. Ryan, department of biochemistry, University of Toronto, is investigating the physiological significance and chemical structure of a new compound, probably related to the sterols, which is excreted by normal humans. A. D. Odell, department of biochemistry, University of Toronto, is attempting to synthesize the progestational hormone or a possible substitute for it by the chemical degradation of an easily procurable bile acid. C. H. Walton, faculty of medicine, University of Manitoba, is, with Dr. M. Dudley's help, making a thorough pollen survey of Manitoba. K. W. Baldwin, department of anatomy, University of Toronto, is studying with A. W. Ham the fate of alveolar epithelium as the lung passes through various stages of embryonic development. D. W. G. Murray, department of surgery, University of Toronto, is continuing clinical studies regarding the effects of heparin on patients. H. T. Malloy, Royal Victoria Hospital, Montreal, is studying congenital haemolytic jaundice in the rat and man. H. B. Collier, department of biochemistry, University of Toronto, is pursuing researches on the enzymatic synthesis of protein. W. J. Auger, Hospital for Sick Children, Toronto, having devised a superior method for obtaining sputum from children, is studying type I pneumonia. D. L. Selby and R. W. I. Urquhart, both of the department of pathological chemistry, University of Toronto, are continuing their studies of experimental nephrosis, using an ingenious technique which they have recently described. E. E. Kuitunen, school of hygiene, University of Toronto, is making a survey of the distribution and type of intestinal parasites in Toronto children. D. G. MacDonald, school of hygiene, University of Toronto, is studying, in cooperation with Dr. A. A. Fletcher, the action of the B vitamins on intestinal tonus and also the cause of bradycardia, which occurs in B_1 deficiency. B. Schachter, department of biochemistry, University of Toronto, is investigating the nature of a compound in pregnant mare's urine to see if it is an oestrogen derivative. M. M. Hoffman, Dalhousie University, Halifax, is determining the physiological properties of an unidentified ketone in

pregnant mare's urine. P. G. Weil, University Clinic, Royal Victoria Hospital, Montreal, is pursuing biochemical studies on the metabolism of progesterone, investigating the sterol metabolism in the toxemias of pregnancy, and studying a new sterol, with reference to the adrenal cortex.

The trustees were pleased to note that medical literature of last year contained over thirty reports of research carried out with the assistance of the Banting Research Foundation. The indication many of these reports gave to the effect that medical science is slowly making inroads upon some of man's most stubborn ills, should, in the opinion of the trustees, be a source of satisfaction to those who showed their appreciation of Sir Frederick Banting's researches by endowing a foundation to allow him and others to continue to advance the state of medical knowledge.

V. E. HENDERSON,
A. W. HAM,
Honorary Secretaries

SPECIAL ARTICLES

THE OCCURRENCE OF GAMMA TOCOPHEROL IN CORN EMBRYO OIL[1]

OLCOTT and Emerson[2] showed that the tocopherols have strong antioxidant powers, and concluded that they represent at least a large part of the antioxidants in wheat-germ and cotton-seed oils. There seems to be no relation between the vitamin and antioxidant activities of these substances, since alpha, which is the most potent as the vitamin, is the weakest antioxidant. Gamma, which is approximately equal in vitamin potency to beta, is definitely a more powerful antioxidant.

It seemed interesting to determine if the antioxidant properties of other vegetable oils might be due to the presence of tocopherols, and those oils with less vitamin potency might contain the less vitamin-potent beta or gamma. Accordingly we investigated corn oil, since Mattill and Crawford[3] had shown it to be rich in antioxidants.

Freshly pressed, unrefined corn oil[4] was assayed for vitamin E. A single dose of 4 gm enabled all four test rats to cast good litters, but at 2 gm only resorptions resulted. Three kilograms of the oil was saponified, the non-saponifiable fraction distributed between high boiling petroleum ether and 92 per cent. methanol, and then dry methanol, and the methanol solution was concentrated, chilled to free it as much as possible of sterols, and finally the oily residue distilled in a molecular still, as previously described for palm oil[5]. The fraction distilling between 120–140°, which contained the bulk of the vitamin, weighed 5.65 gm. Fed at a level of 15 mg, three resorptions and one litter resulted, but at 45 mg all four rats fed had litters. Karrer and Keller[6] measured by titration with gold chloride the tocopherol content of a non-saponifiable fraction of corn oil, freed from most of the sterols, and found it to be 0.2 per cent. Assuming the critical level of gamma tocopherol to be 6 mg, Karrer and Keller's measurement would appear to be in reasonable agreement with the results of our feeding tests.

The concentrate was treated with cyanic acid in benzene, as previously described. The only tocopherol which could be isolated was gamma, whose allophanate, mp. 137–140°, gave no depression on admixture with gamma tocopheryl allophanate previously obtained from cotton-seed oil. The yield was about 700 mg.

The allophanate was saponified, and the free tocopherol fed at levels of 3 to 6 mg. Of four rats fed 3 mg one had a litter and three resorbed, while of five rats receiving 6 mg, two had litters and three resorbed.

The gamma allophanate, on admixture with beta allophanate, mp 143–6°, melted at 130–5°. This, together with the complete difference in the habit and appearance of the two allophanates, would seem to leave little reason to doubt their non-identity. On the other hand, the admixture of alpha tocopheryl allophanate mp 158–60° lowers the melting point of gamma only two or three degrees, which makes it very difficult to be certain that a preparation of gamma is not contaminated with alpha. However, the absence of any considerable amounts of alpha from corn oil greatly facilitates the preparation of gamma in a comparatively pure form.

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[1] Aided by grants from the Department of Agriculture, University of California and by Merck and Company, Inc., Rahway, N. J. Assistance was rendered by the Works Progress Administration, Project No. 10482 A-5.

[2] H. S. Olcott and O. H. Emerson, *Jour. Am. Chem. Soc.*, 59: 1008, 1937.

[3] H. A. Mattill and Blanche Crawford, *Jour. Ind. Eng. Chem.*, 22: 341, 1930.

[4] The corn oil was kindly supplied by the Miner Millard Milling Co., Wilkes-Barre, Pa.

[5] O. H. Emerson, G. A. Emerson, Ali Mohammad and H. M. Evans, *Jour. Biol. Chem.*, 122: 99, 1937.

THE QUANTITATIVE DETERMINATION OF VITAMIN C IN MILK

RECENT studies[1, 2, 3, 4] have shown that there are a number of important factors which may influence the

[6] P. Karrer and H. Keller, *Helv. Chim. Acta*, 21: 1161, 1938.

[1] P. F. Sharp, *Jour. Dairy Science*, 21: 85, 1938.

[2] S. K. Kon and M. B. Watson, *Jour. Soc. Chem. Ind.*, 55: 508, 1936.

results obtained in the determination of vitamin C in milk by titration with 2,6-dichlorobenzenoneindophenol. Such variables as temperature, light, method of standardizing the dye (2,6-dichlorobenzenoneindophenol), stability of the dye, contact of the milk with oxygen, catalytic elements present and methods of precipitating milk protein have been outstanding in these reports.

The present work was undertaken to simplify and to make reproducible a quantitative procedure for determining the total amount of vitamin C in milk as it comes from the dairy cow.

Kon and Watson[5] have shown that ascorbic acid (vitamin C) in milk as it leaves the cow's teat is in the reduced form. In this form the vitamin C content of milk may be determined quantitatively by direct titration with 2,6-dichlorobenzenoneindophenol. Should the milk, however, in the process of collection, be exposed even very briefly to contact with air, catalytic metals, light or heat, an unavoidable loss of ascorbic acid occurs due to oxidation. In order to eliminate the effect of these factors in collecting samples directly from cows of the college herd, a special apparatus was devised (See Fig. 1).

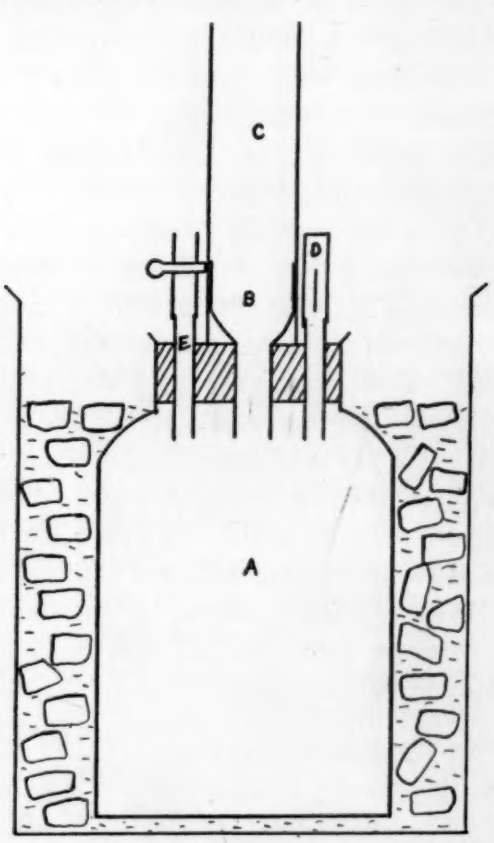

FIG. 1

A 500 ml dark-glass bottle (A) was placed inside a 2-liter beaker and surrounded with ice and water. This was done a short time prior to milking in order that the bottle might become thoroughly chilled. The bottle was fitted with a 3-holed rubber stopper. Through one hole of this stopper projected a glass adapter (B) having a funnel stem. A dark rubber tube (C), thin enough to be quite pliable and about one inch in diameter, was stretched over the adapter and pulled down to the rubber stopper. The upper part of this tube extended about three inches above the top of the adapter and was the part which was slipped over the teat of the cow during milking. A tube fitted with a Bunsen valve (D) passed through another hole in the stopper. Another glass tube (E) passed through the third hole and was provided with a short length of rubber tubing so that it could be closed off with a pinch clamp. The size of this tube was such as to permit the insertion of a 10 ml bulb pipette for removal of samples. Before milking, the air in the dark bottle was expelled through the Bunsen valve by closing all outlets with pinch clamps and flushing with carbon dioxide from a pressure tank.

To determine if the ascorbic acid of milk obtained in the above apparatus was completely in the reduced form, two samples were removed and titrated immediately, while other samples were subjected to treatment with hydrogen sulfide and then titrated after removing excess hydrogen sulfide with carbon dioxide. Typical results are given in Tables 1 and 2.

TABLE 1
TITRATION OF UNTREATED MILK SAMPLES

Ml milk	Ml dye	Mg ascorbic acid per aliquot	Mg ascorbic acid per liter
10.00	1.90	0.2280	22.80
10.00	1.91	0.2292	22.92
	Average . .	0.2286	22.86

TABLE 2
TITRATION OF HYDROGEN SULFIDE TREATED SAMPLES

Ml milk	Ml dye	Length of treatment in minutes	Mg ascorbic acid per aliquot	Mg ascorbic acid per liter
10.00	1.91	10	0.2292	22.92
10.00	1.91	10	0.2292	22.92
		Average	0.2292	22.92
10.00	1.92	30	0.2304	23.04
10.00	1.91	30	0.2292	22.92
		Average	0.2298	22.98
10.00	1.91	100	0.2292	22.92

The instability of 2,6-dichlorobenzenoneindophenol solutions reported by some workers was satisfactorily overcome by preliminary extraction of the dye with anhydrous ethyl ether. Solutions of dye, thus purified, and standardized according to the methods of Menaker and Guerrant,[6] remained perfectly stable and gave sharp end points over a period of 21 days.

Metaphosphoric acid was found by Fujita and

[3] R. R. Musulin and C. G. King, *Jour. Biol. Chem.*, 116: 409, 1936.

[4] C. H. Whitnah, W. H. Riddell and W. J. Caulfield, *Jour. Dairy Science*, 19: 373, 1936.

[5] S. K. Kon and M. B. Watson, *Biochem. Jour.*, 31: 223, 1937.

[6] M. H. Menaker and N. B. Guerrant, *Jour. Ind. Eng. Chem.*, Anal. Ed., 10: 25, 1938.

Iwatake,[7] Lyman, Schultze and King[8] and others to protect vitamin C in solution against oxidation. This property, combined with the protein-precipitating ability of metaphosphoric acid, was made use of in the present work in preparing milk samples for titration. To eliminate the uncertain protein-precipitating power encountered with ordinary metaphosphoric acid solutions, the required volume of a stable sodium metaphosphate solution, prepared by the method of Briggs,[9] was acidified just before each titration and added to the milk. Using 10 ml of 10 per cent. sodium metaphosphate solution, the addition of 0.6 ml of concentrated hydrochloric acid was found to bring the pH of the solution to a point (pH 2.5–3.0) where immediate and complete flocculation of protein resulted upon addition of the metaphosphate solution to 10 ml of milk.

Titrations were made in the presence of precipitated milk protein. By repeated centrifuging and washing of the milk protein followed by separate titrations of combined centrifugate and protein residue, it was found that slightly higher ascorbic acid values were obtained in titrations of milk in the presence of precipitated protein. However, upon the addition of pure ascorbic acid to the protein residues and repetition of the centrifuging procedures and titrations, it was shown that the slightly higher apparent values obtained in the presence of milk protein were due to adsorption of negatively charged dye by positively charged protein. No adsorption of ascorbic acid by the milk protein could be demonstrated.

The new apparatus and improved technique provides a simple but reliable method of obtaining and determining vitamin C of milk in its naturally occurring form. The improvements mentioned should be of value in following fluctuations of vitamin C in milk at different stages of lactation, at various seasons of the years, during feeding experiments and under numerous other conditions.

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A PLANT GROWTH INHIBITOR

DURING the course of physiological investigations on the plant hormone relationships in radish, strain French Breakfast, an ether extraction was made of 4.935 grams fresh weight of cotyledons from seven-day-old seedlings. These plants had been grown in the open in rich, loamy soil. The extraction was carried out according to the simplified auxin extraction method of Van Overbeek.[1] On testing the extract by the Avena test (Went and Thimann[2]) positive curvatures of from 17 to 23 degrees were found instead of the usual negative ones. (If the substance being tested is growth-promoting then the Avena plant will grow more rapidly on the side on which the substance is applied. Thus, because of this unsymmetrical growth, the plant will become curved in a direction away from the side on which the substance is applied. This is known as a negative curvature. If, however, the material causes an inhibition of growth then the plant will likewise grow unsymmetrically, but now the resulting curvature will be in a direction toward the side of application of the substance. This is known as a positive curvature.)

The relation between the concentration of the extract and degrees of positive curvature was investigated. In determining the amount of positive curvature 48 Avena plants were used at each dilution value. The inhibitor, extracted as above, was taken up in 1½ per cent. agar and cut into blocks 1.6×2×2 mm for application to the test plants. The standard Avena technique for auxin determination was used except that the curvature—positive in this case—was measured 150 minutes after applying the inhibitor instead of after 90 minutes, as is customary when testing growth-promoting substances. The results are seen in Fig. 1.

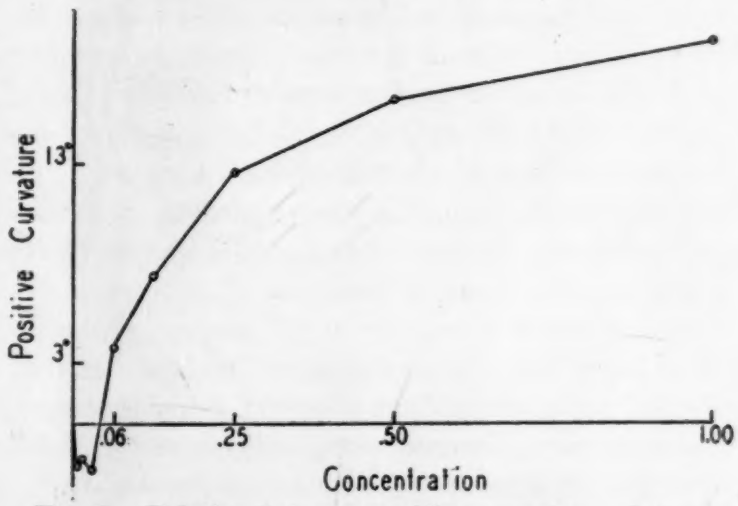

FIG. 1. Relation between positive curvature of Avena plants and two-fold dilutions of inhibitor substance.

This graph shows that positive curvatures between 3 to 13 degrees are proportional to the concentration of the inhibitor.

Using the method given by Schneider and Went[3] a Photokymograph test was made of the reaction time of the coleoptile to growth inhibitor. The results are pre-

[7] A. Fujita and D. Iwatake, *Biochem. Zeits.*, 277: 293, 1935.

[8] C. M. Lyman, M. O. Schultze and C. G. King, *Jour. Biol. Chem.*, 118: 757, 1937.

[9] D. Briggs, *Proc. Soc. Exp. Biol. and Med.*, 37: 634, 1938.

[1] J. Van Overbeek, *Proc. Nat. Acad. Sci.*, 24: 42, 1938.

[2] F. W. Went and K. V. Thimann, "Phytohormones," Macmillan Company, New York, 1937.

[3] C. L. Schneider and F. W. Went, *Bot. Gaz.*, 99: 470, 1938.

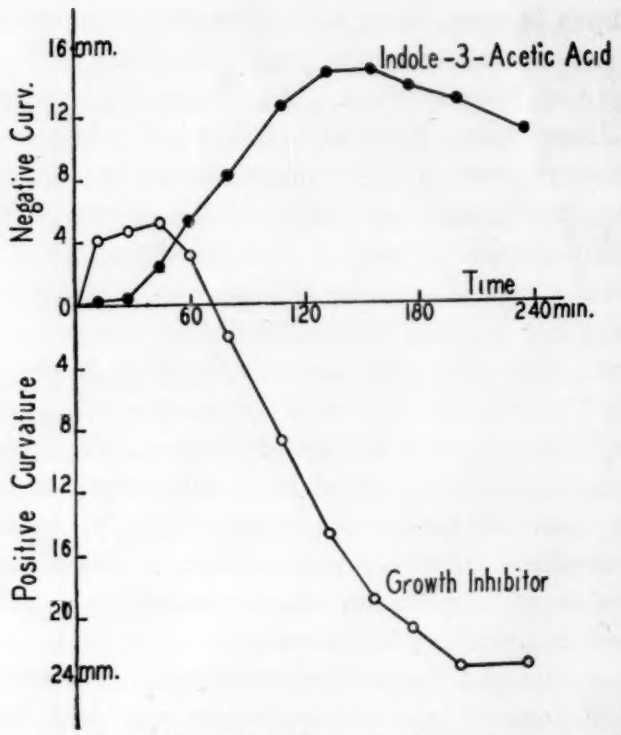

FIG. 2. Curvature rate of Avena plants upon application of: (*a*) .05 mg/liter, indole–3–acetic acid, and (*b*) growth inhibitor. (Ordinate values given as mm deviation of the extended coleoptile from the vertical position.)

sented in Fig. 2. It is observed that a negative curvature is initiated which rapidly changes between the first and second hour to a positive curvature, reaching its maximum three hours after the application of the inhibitor. It is interesting to note that the reaction rate for this negative curvature is different from the negative curvature caused by auxin. This is shown by the control run made at the same time as the inhibitor test but by using a growth-promoting substance, indole –3–acetic acid, .05 mg per liter. Each point on the graph is the average of twelve Avena test plants.

Inhibitor was found in the cotyledons of radish plants grown in the light or dark, but it was not found in the hypocotyl in either case.

The inhibitor substance is of neutral character. Accordingly as one would expect on the basis of Went's[4] potential gradient theory of auxin transport, it should be transported acropetally as well as basipetally. Experiments prove this to be the case, as was shown by equal amounts of inhibitor passing through normal and inverted 4 mm long sections of Avena coleoptiles. Similar experiments show there is likewise no inhibitor transport polarity in radish hypocotyl sections.

In conclusion, it may be said that the positive curvatures resulting from the application of the inhibitor are not to be considered the same as the positive curvatures resulting from the retardation of the physiological tip regeneration in the Avena coleoptile because these are usually of slight magnitude, and furthermore they are never preceded by a negative curvature during the first hour.

[4] F. W. Went, *Jahrb. wiss. Bot.*, 76: 582, 1932.

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